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(REV 12-29-99)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

PS-12772

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)

09/581384

INTERNATIONAL APPLICATION NO.
197 55 693.0INTERNATIONAL FILING DATE
December 15, 1998PRIORITY DATE CLAIMED
December 16, 1997

TITLE OF INVENTION METHOD FOR GASIFYING ORGANIC SUBSTANCES AND SUBSTANCE MIXTURE

APPLICANT(S) FOR DO/EO/US

Heinz-Jurgen Muhlen and Christoph Schmidt

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

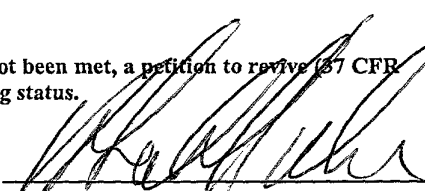
1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:
Copy of International Search Report dated May 19, 1999
Three (3) sheets of drawings
Cover sheet of WO 99/31197

"Express Mail" mailing label number EF32181985 US

09581384, 081000

U.S. APPLICATION NO. (if known, see 37 CFR 1.40) 09/581384		INTERNATIONAL APPLICATION NO. 197 55 693.0		ATTORNEY'S DOCKET NUMBER PS-12772	
17. <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$970.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$840.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$690.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$670.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$96.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS PTO USE ONLY	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	29 - 20 =	9	X \$18.00	\$	162 00
Independent claims	2 - 3 =	0	X \$78.00	\$	0 00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$260.00	\$	
TOTAL OF ABOVE CALCULATIONS =				\$	1,002 00
Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				\$	
SUBTOTAL =				\$	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	
TOTAL FEES ENCLOSED =				\$	1,002 00
				Amount to be refunded:	\$
				charged:	\$
a. <input checked="" type="checkbox"/> A check in the amount of \$ <u>1,002.00</u> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>22-0347</u> . A duplicate copy of this sheet is enclosed.					
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO: VICKERS, DANIELS & YOUNG 50 Public Square, Suite 2000 Cleveland, Ohio 44113					
				SIGNATURE:  ROBERT V. VICKERS NAME 19,504 REGISTRATION NUMBER	

09./581384
533 Rec'd PCT/PTO 13 JUN 2000

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of : Heinz-Jürgen Mühlen and Christoph Schmid
For : METHOD FOR GASIFYING ORGANIC
SUBSTANCES AND SUBSTANCE MIXTURE
International Application No. : PCT/EP98/08217
International Filing Date : December 15, 1998
Priority Application No. : 197 55 693.0
Priority Filing Date : December 16, 1997
Our Docket : PS-12772

PRELIMINARY AMENDMENT

Asst. Commissioner for Patents
Box PCT
Washington, D.C. 20231

Dear Sir:

AMENDMENT

Please amend the above-identified patent application as follows:

IN THE ABSTRACT:

Please add an abstract as follows:

--ABSTRACT OF THE DISCLOSURE

The invention relates to a method and an apparatus for gasifying organic substances and substance mixtures in which the organic substances are fed into a pyrolysis reactor and the organic substances are held in contact with a heat carrier medium. The solid residual containing carbon and

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containing carbon and the heated carrier medium are fed to a firing in which the residue containing carbon is fired and the heated carrier medium is heated and fed again to the pyrolysis reaction. The pyrolysis gases that contain tar are reheated in a second reaction zone so that a gas product is obtained which has a high caloric value. The pyrolysis is carried out in a moving bed reactor or a rotary drum. A reactant such as steam can be mixed in with the pyrolysis gases and fed into an indirect heat exchanger in which the pyrolysis gases react with the reactant. The waste gases produced from the firing are fed through the indirect heat exchanger such that their heat content is utilized for the reaction of the pyrolysis gases with the reactant. The ash of the solid residue containing carbon and the heat carrier medium is removed from the firing and recycled into the pyrolysis reactor at the input end for the organic material.--;

Page 6, before line 30, insert the following:

--In summary, there is provided a method for the gasifying of organic containing substances and/or substance mixtures. The organic substances are fed into a pyrolysis reactor in which the organic substances are kept in contact with a heat carrier medium such that a rapid pyrolysis takes place in which the organic substances are reacted into pyrolysis products. The pyrolysis products include pyrolysis gases with condensable substances and a solid residue containing carbon. The solid residue containing carbon and the heat carrier medium are fed to a firing in which the residue containing carbon is fired and the heat carrier medium is heated and fed again to the pyrolysis reaction. The reuse of the heat carrier medium is referred to as the heat carrier medium cycle. Pyrolysis gases which include tar are reheated in a second reaction zone so that a gas product is obtained which has a high caloric value. The pyrolysis of the organic containing substances and/or substance mixtures is carried out in a moving bed reactor or a rotary drum.

In one preferable modification of the invention, a reactant, such as steam, is mixed in with the pyrolysis gases and then the reactant and pyrolysis gases are fed into an indirect heat exchanger in which the pyrolysis gases react with the reactant.

In another preferable modification, the waste gases produced from the firing are fed through the indirect heat exchanger such that their heat content is utilized for the reaction of the pyrolysis gases with the reactant.

In still another preferable modification, the ash of the solid residue which contains carbon and the heat carrier medium is removed from the firing and recycled into the pyrolysis reactor at the input end for the organic material.

In yet another preferable modification, the pyrolysis is carried out at a temperature of about 550-650°C. In still yet another preferable modification, the reaction of the pyrolysis gases with steam is carried out at a temperature of about 900-1000°C.

In a further preferable modification, the reaction of the pyrolysis gases with a reactant, such as steam, is carried out in the presence of a catalyst.

In still a further preferable modification, dolomite, calcite, nickel, nickel oxide, nickel aluminate, and/or nickel spinel are used as a catalyst.

In yet a further preferable modification, one or more catalysts are used simultaneously as the heat carrier medium for the heat carrier medium cycle.

In still yet a further preferable modification, the hot pyrolysis gases are dedusted before the addition of the reactant, such as steam.

In another preferable modification, the catalyst is fed to the hot pyrolysis gases in an entrained flow mode and is separated out after the reaction with steam, and returned to the hot pyrolysis gases in the heat carrier medium cycle.

In still another preferable modification, the pyrolysis gases are dedusted and quenched after the reaction with the reactant.

In yet another preferable modification, a portion of the pyrolysis gas is fired and the resulting heat is utilized for the pyrolysis and/or the reaction with the reactant.

In still yet another preferable modification, the solid residue containing carbon and the heat carrier medium are fed to a grate firing.

In a further preferable modification, the gasification of the organic containing substances and/or substance mixtures is carried out with use of a pyrolysis reactor, a firing for the pyrolysis residue, a reaction zone for the pyrolysis gases, and a heat carrier cycle between the pyrolysis reaction and the firing.

In still a further preferable modification, the pyrolysis reactor includes a shaft kiln or a rotary drum that is equipped with a sluice for the organic containing substances and/or substance mixtures and a sluice for the heat carrier medium.

In yet a further preferable modification, the pyrolysis reactor includes a firing with a grate and the shaft kiln or rotary drum has a feed for the firing.

In still yet a further preferable modification, the waste gases produced from the firing can be fed to a heat exchanger that is connected with the shaft kiln or rotary drum via a line for the pyrolysis gases.

Another object of the present invention is the provision of a pyrolysis process that produces a small condensation portion.

Further objects and advantages of the invention will become apparent to those skilled in the art from reading and understanding the following detailed description of various embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference may now be had to the drawings, which illustrate various embodiments that the invention may take in physical form and in certain parts and arrangement of parts wherein;--;

before line 9, insert the following heading, centered on the page --**DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**--;

line 9, delete "It is evident from Figure 1" and substitute therefor the following:

--Referring now to the drawings wherein the showings are for the purpose of illustrating preferred embodiments of the invention only, and not for the purpose of limiting the same, reference is made to FIGURE 1 which illustrates--;

Page 8, line 3, delete "Figure" and substitute therefor --FIGURE--;

line 15, delete "Figure" and substitute therefor --FIGURE--;

line 22, delete "Figure" and substitute therefor --FIGURE--;

Page 10, delete the entirety of 17 and substitute therefor, centered on the page --**EXAMPLE 1**--;

Page 12, after line 3, insert the following paragraph:

--The invention has been described with reference to a preferred embodiment and alternatives thereof. It is believed that many modifications and alterations to the embodiments discussed herein

will readily suggest themselves to those skilled in the art upon reading and understanding the detailed description of the invention. It is intended to include all such modifications and alterations insofar as they come within the scope of the present invention.--;

Delete the entirety of pages 13, 14, and 15; and,

Page 16, line 1, delete "Claims" and substitute therefor --We claim:--.

IN THE CLAIMS:

Please delete claims 12 and 16.

Please amend claims 1-11, 13-15, and 17-20, and add new claims 21-31 as follows:

1. (Amended) [Method] A method for the gasifying of organic containing substances [and] and/or substance mixtures in which
 - a) the organic containing substances and/or substance mixtures are fed into a pyrolysis reactor in which the organic containing substances and/or substance mixtures are kept in contact with a heat carrier medium whereby a rapid pyrolysis takes place in which the organic substances are reacted into pyrolysis products whereby the pyrolysis products consist of pyrolysis gases with condensable substances and a solid residue containing carbon,
 - b) the solid residue containing carbon and the heat carrier medium are fed to a firing in which the residue containing carbon is fired and the heat carrier medium heated and fed again to the pyrolysis reaction [(heat carrier medium cycle)],
 - c) the pyrolysis gases containing tar are reheated in a second reaction zone so that a gas product is obtained [with at] which has a high caloric value,
[characterized in that]
 - d) the pyrolysis is carried out in a moving bed reactor or a rotary drum,

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g) [the firing] waste gases produced from the firing are fed through [the] an indirect heat exchanger such that their heat content is utilized for the reaction of the pyrolysis gases with the reactant, and

h) [the] ash of the solid residue [containing] which contains carbon and the heat carrier medium [is] are removed from the firing and recycled into the pyrolysis reactor at the input end for the organic [material] substances and/or substance mixtures.

2. (Amended) [Method] The method according to [Claim] claim 1, [characterized in that] wherein the pyrolysis is carried out at a temperature of about 550-650°C.

3. (Amended) [Method] The method according to [Claims 1 and 2] claim 1,
[characterized in that] wherein the reaction of the pyrolysis gases with [steam] the reactant is carried
out at a temperature of about 900-1000°C.

4. (Amended) [Method] The method according to [Claims 1-3] claim 1,
[characterized in that] wherein the reaction of the pyrolysis gases with [steam] said reactant is carried
out in the presence of a catalyst.

5. (Amended) [Method] The method according to [Claim] claim 4, [characterized in that] wherein said catalyst includes a material selected from the group consisting of dolomite, calcite, nickel, nickel oxide, nickel aluminate, [or] nickel spinel [is used as a catalyst] and mixtures thereof.

6. (Amended) [Method] The method according to [Claim] claim 5, [characterized in that the catalysts are] wherein at least one of said catalyst is used simultaneously as the heat carrier medium [for the] in a heat carrier medium cycle.

7. (Amended) [Method] The method according to [Claims 1-6] claim 1, [characterized in that] wherein the hot pyrolysis gases are dedusted before the addition of [steam] said reactant.

8. (Amended) [Method] The method according to [Claims 1-7] claim 1, [characterized in that] wherein the at least one of said catalyst is fed to the hot pyrolysis gases in an entrained flow mode and is separated out after the reaction with [steam] said reactant, and then returned to the hot pyrolysis gases [in the cycle].

9. (Amended) [Method] The method according to [one or more of Claims 1-8] claim 1, [characterized in that] wherein the pyrolysis gases are dedusted and quenched after the reaction with [steam] said reactant.

10. (Amended) [Method] The method according to [one of Claims 1 -9] claim 1, [characterized in that] wherein a portion of the pyrolysis gas is fired and the produced heat is at least partially utilized for [the] a process selected from the group consisting of said pyrolysis [and/or], [the reaction with steam] said reaction of said pyrolysis gases with said reactant, and combinations thereof.

11. (Amended) [Method] The method according to [one of Claims 1-10] claim 1, [characterized in that] wherein the solid residue [containing] which includes carbon and the heat carrier medium are fed to a grate firing.

13. (Amended) [Apparatus] The method according to [Claim 12] claim 1, [characterized in that] wherein the heat carrier medium [consists of] includes a fire-resistant [materials such as] material selected from the group consisting of sand, gravel, split, aluminum silicate, corundum, graywacke, quartzite, [or] cordierite, and mixtures thereof.

14. [Apparatus] The method according to [Claim 12] claim 1, [characterized in that] wherein the heat carrier medium [consists of] includes molded bodies [composed of metallic or non-metallic substances such as steel or ceramic balls] consisting of metallic balls, non-metallic balls, and combinations thereof.

15. [Apparatus] The method according to [Claims 13 and 14] claim 13, [characterized in that] wherein the heat carrier medium has a grain size of about 1-40mm.

17. [Apparatus] The method according to [one or more of Claims 12-16] claim 1,
[characterized in that] wherein the heat exchanger [(417) has] includes a catalyst filling.

18. [Apparatus] The method according to [one or more of Claims 10-17] claim 17,
[characterized in that] wherein the pipes of the heat exchanger [(417) consist of] include catalytically
active material.

19. [Apparatus] The method according to [one or more of Claims 12-18] claim 17,
[characterized in that] wherein the heat exchanger [(417)] is assigned to a solid bed reactor with
catalyst feed.

20. [Apparatus] The method according to [one or more of Claims 12-19] claim 1,
[characterized in that] wherein the heat exchanger [(417)] is first connected to a filter for dedusting.

Add the following new claims:

21. An apparatus for gasifying organic containing substances and/or substance mixtures
comprising a pyrolysis reactor having a firing for solid pyrolysis residue formed in the pyrolysis
reactor, a reaction zone for the pyrolysis gases formed in the pyrolysis reactor, and a heat carrier
medium that is recycled between the pyrolysis reaction and the firing, said pyrolysis reaction
including a shaft kiln or a rotary drum that is equipped with a sluice for receiving said organic
containing substances and/or substance mixtures and a sluice for the heat carrier medium, said firing

including a grate, said shaft kiln or rotary drum having a feed opening to allow materials to pass to the firing.

22. The apparatus according to claim 21, wherein waste gases are formed during said firing, said waste gases fed to a heat exchanger used to heat materials in said shaft kiln or rotary drum.

23. The apparatus according to claim 21, wherein said firing includes a discharge opening for said heat carrier medium to be discharged onto a discharge apparatus, said discharge apparatus selected from the group consisting of a worm, conveyor, and combinations thereof.

24. The apparatus according to claim 21, wherein the heat carrier medium includes a fire-resistant material selected from the group consisting of sand, gravel, split, aluminum silicate, corundum, graywacke, quartzite, cordierite, and mixtures thereof.

25. The apparatus according to claim 21, wherein the heat carrier medium includes molded bodies selected from the group consisting of metallic substances, non-metallic substances, and mixtures thereof, said molded bodies including substantially spherical bodies.

26. The apparatus according to claim 24, wherein the heat carrier medium has a grain size of about 1-40mm.

27. The apparatus according to claim 21, wherein said firing is performed as a grate firing.

28. The apparatus according to claim 22, wherein said heat exchanger includes a catalyst filling.

29. The apparatus according to claim 22, wherein said pipes of the heat exchanger include catalytically active material.

30. The apparatus according to claim 22, wherein said heat exchanger is used with a solid bed reactor with catalyst feed.

31. The apparatus according to claim 21, wherein gases passing into said heat exchanger are first filtered to dedust the gases.

REMARKS

Applicants reiterate and again claim priority on the basis of German application 197 55 693.0, filed December 16, 1997, and PCT/EP98/08217, filed December 15, 1998.

The above-identified patent application was amended to place the patent application in better form for United States patent practice. Applicants submit that the amendments to the specification do not constitute new matter. An abstract has also been added by this amendment. A separate page which includes the abstract is also enclosed. Finally, Applicants have amended the claims to remove the multiple dependency, to clarify the claim language, and have added new claims to obtain claim

coverage on other aspects of the invention. Applicants submit that the claims are in proper and allowable form. Substantive examination on the basis of this Preliminary Amendment is respectfully requested.

If it is determined that any additional fee is necessary, or if there has been any overpayment, the Commissioner is authorized to charge or debit, as appropriate, our Deposit Account No. 22-0347.

Respectfully submitted,
VICKERS, DANIELS & YOUNG

By: 

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METHOD FOR GASIFYING ORGANIC SUBSTANCES AND SUBSTANCE MIXTURES

The invention relates to a method for gasifying organic substances and substance mixtures according to the generic terms of Claim 1.

From US-PS 4,568,362, a method for gasifying organic substances and substance mixtures is known in which the organic substances are directed into a pyrolysis reactor in which the organic substances come into contact with a heat carrier medium which causes rapid pyrolysis in which the organic substances are converted into pyrolysis products, that is, pyrolysis gases with substances that can be condensed and solid residue containing carbon. The heat energy needed for the pyrolysis is generated by firing the solid residue containing carbon. In a second reaction zone, the pyrolysis gases that contain tar are subjected to cracking reactions and reactions with steam such that a product gas with a high caloric value is obtained.

In this method, the pyrolysis as well as the firing of the solid residue containing carbon take place in a fluidized bed. In the upper part of the pyrolysis fluidized bed reactor, a reaction zone is provided for the pyrolysis gases containing tar.

The heat carrier medium is discharged together with the solid residue containing carbon in part through the reactor head of the pyrolysis fluidized

bed reactor and the remaining portion via a line that is mounted on the upper fluidized bed limit, and fed to the fluidized bed firing. There, the solid residue containing carbon is fired and the heat carrier medium heated up. The heated heat carrier medium and the ashes are discharged from the fluidized bed firing together with the waste gas, and separated in a gas-solid separator mounted above the fluidized bed pyrolysis reactor, and fed to the reaction zone of the pyrolysis reactor from which it again falls into the fluidized bed of the pyrolysis reactor (heat carrier medium cycle).

It is very costly to operate the fluidized beds and it is hardly possible to control the reactions of the pyrolysis gases in the reaction zone.

The object of the invention is to make available a method for generating a gas with a high caloric value that is easy to perform. In this process, a small condensation portion is preferred. A further object of the invention is to make available a simple apparatus for carrying out the method.

With respect to the method, this object is resolved by the combination of features in Claim 1. According to the invention, the pyrolysis is carried out in a fluidized bed reactor or a rotary drum, the pyrolysis gases are mixed, if necessary, with a reactant such as steam, and they are fed into an indirect heat exchanger in which the pyrolysis gases react with the reactant. The solid residue containing carbon and the heat exchanger medium are fed to a firing. The firing waste gases are fed through the indirect heat exchanger such that their heat content is used for the reaction of the pyrolysis gases with the reactant. The ashes of the solid residue containing carbon and the heat carrier medium taken from the firing are fed into the pyrolysis reactor at the entry end for the organic substance.

The invention involves the basic concept that gasifying methods should be divided into three method steps that can be carried out easily. In a first method step, pyrolysis of the substances used takes place rapidly. In the process, the goal is to have as little as possible of the condensable substances in the pyrolysis gases. The rapid pyrolysis is ensured by performing the pyrolysis of the substances used at a temperature of 550-650°C.

In a second method step, the pyrolysis gases are heated and reacted with steam to adjust the product gas quality. The reaction of the pyrolysis gases is carried out with steam at a temperature of 900-1000°C.

In a third method step, the solid pyrolysis residue containing carbon is fired. The heat generated in the process is used for the pyrolysis and the reaction of the pyrolysis gases. Furthermore, the heat carrier medium is heated up in the firing and then is conveyed back into the pyrolysis reactor. The heat transfer for the reaction of the pyrolysis gases with steam takes place in a heat exchanger that is heated by the waste gases from the firing.

The advantage of this division of the three method steps is that each method step and the combination of the method steps can be arranged according to the set standard of gas product quality.

The set standard for the gas product quality is first of all, a higher caloric value. Furthermore, the steam content is increased by the second method step so that the gas product is very well suited for use as a synthesis gas, and energy use in connection with fuel cells can also be considered. Naturally, use to obtain energy via a gas motor or gas turbine is also possible.

The reactant is steam. It is possible to avoid the addition of steam when sufficient water vapor is contained in the feedstock used, for example, when the material used is not dried or only to a limited extent. Furthermore, it is possible that the pyrolysis gases that form contain sufficient water vapor when sufficient steam develops in the pyrolysis of the substances used. It is also possible to provide the addition of steam in the pyrolysis step.

With the method according to the invention, basically all organic substances and substance mixtures can be gasified. However, it is preferable to gasify biomasses.

The substances used must be pretreated before they are fed to the pyrolysis. The pretreatment is generally limited to drying and if necessary, to pulverization. In the process, no great restrictions are set for the lumpiness of the substances used because the pyrolysis is carried out in a fluidized bed with a heat carrier medium.

To improve the cracking of the noncondensable substances in the pyrolysis gas, a catalyst can be provided in the reaction of the pyrolysis gases with steam. Preferred catalysts are dolomite, calcite, nickel, nickel oxide, nickel aluminate, or nickel spinel.

5 When dolomite is used, it is advantageous to calcinate the dolomite at the reaction temperature of 900-1000°C, and the resulting calcium/magnesium oxide has particularly high catalytic activity.

10 The reaction temperature of 900-1000°C is advantageous for the reaction of the pyrolysis gas with steam, because in this temperature range, the sulfur sensitivity of the named catalysts is very much reduced. There is the possibility of regenerating the catalysts from time to time in situ by the addition of a small amount of air at temperatures above 1000°C.

15 The catalysts can also be used as a heat carrier medium. This manner of proceeding has the advantage that the catalysts are periodically regenerated in the heat carrier cycle.

To prevent the catalyst from being deactivated by dust, it is recommended that the hot pyrolysis gases be dedusted before addition of the steam.

20 In cases in which, because of the substances used, there is only minimal development of pyrolysis coke and thus the heat developing in the firing is not sufficient for pyrolysis and reaction with steam, a portion of the pyrolysis gas can be fired to generate heat.

25 The firing of a portion of the pyrolysis gas to generate heat is also required when the pyrolysis coke is used as a material, for example, for the production of activated charcoal or grilling charcoal or charcoal briquettes. So that the pyrolysis coke can be transferred out well, the grain size of the heat carrier medium must be small enough that the heat carrier medium can be separated from the pyrolysis coke without any problem.

30 For the device according to the invention, simple and cost-effective components can be used that are known as such and easily available. With these components, the device according to the invention can easily be constructed.

The pyrolysis takes place in a moving bed reactor using a heat carrier medium. A shaft kiln is primarily used for this into which the mixture consisting of the material to be gasified and the heat carrier medium is loaded from above. The mixture travels through the shaft kiln. Rapid pyrolysis occurs due to the intimate contact of the material used with the heat carrier medium.

So that even with heterogeneous materials, transport through the shaft kiln is ensured, built-in structures or spiral conveyors can be provided inside the shaft kiln. The built-in structures also have the advantage that the pyrolysis gases developing can better escape upwards through the moving bed. Nevertheless, the equipment expense is increased in this way.

Basically, the pyrolysis can also be carried out in a rotary drum or a double-deck oven, although here as well, the equipment cost would be greater.

The mixture consisting of the heat carrier medium and the pyrolysis residue can be transferred into the firing via commercially available aggregates such as conveyor worms, swivel grates, rotating grates or cellular wheel sluices. In combination with a grate firing, however, the use of feeding rams is preferred. When an underfeed stoker is used, the use of conveyor worms is preferred. The firing waste gases are fed through an indirect heat exchanger that simultaneously serves as chemical reactor in which the pyrolysis gases react with steam. Such heat exchangers are known, for example, in refineries as steam reformers or reformers.

Also for the conveyance of the heat carrier medium from the firing into the shaft kiln, conventional conveyance devices can be used, such as vibrating conveyors, bucket conveyors, or chain conveyors. The demands on conveyance technique also correspond to the requirements that appear in the steel industry or in the field of coking, so that excessive expense is not required for layout of the aggregates.

The heat carrier medium must have sufficient mechanical, chemical, and thermal stability in the temperature range of 600-1000°C. Fire-resistant substances such as sand, silicon, grit, aluminum silicates, corundum, graywacke, quartzite, or cordierite are used. The use of molded bodies of metallic or non-

metallic materials or combinations of them, such as steel or ceramic balls is also possible.

With respect to the particle size, the heat carrier medium must be fine enough to be able to make intimate contact with the material used so that a good transfer of heat can take place. On the other hand, the particles of the heat carrier medium must be big enough that there is sufficient empty volume through which the pyrolysis gases can flow.

These requirements are best fulfilled when the heat carrier medium has a grain size of 1-40 mm. This grain size also has the advantage that the heat carrier medium can be separated well from the ash of the pyrolysis residue after the firing.

As mentioned above, a catalyst can be provided for the reaction of the pyrolysis gases with steam. For this purpose, a catalyst bed can be mounted in the heat exchanger. Depending on whether the pyrolysis gases are fed through the pipes of the heat exchanger or outside the pipes through heat exchanger, the catalyst bed is mounted inside or outside of the pipes of the heat exchanger. It is also possible to use a catalytically active material for the heat exchanger pipes such as corundum with nickel or nickel oxide. It is also possible to provide a solid bed reactor with a catalyst bed behind the heat exchanger.

If the reaction of the pyrolysis gases with steam is to be supported by a catalyst, it is recommended that the hot pyrolysis gases be dedusted with a filter before contact with the catalyst.

The method steps named above as well as those claimed and described in the embodiment example, which are to be used according to the invention, as well as structural components are not subject to any special exceptional restrictions with respect to their method restrictions, their size, shape, material selection, and technical conception, so that the selection criteria known in the particular area of application in each case can be used without any limitations.

Further details, features, and advantages of the object of the invention result from the following description of the related illustration in which, as an

example, a preferred embodiment of the gasifying of organic materials is represented. Shown in the illustration are:

Figure 1, a diagram of the method according to the invention,

Figure 2, the mass and energy balance of the pyrolysis and reaction steps,

Figure 3, the mass and energy balance of the firing, and

Figure 4, a schematic representation of a device for carrying out the method according to the invention.

It is evident from Figure 1 that the material to be gasified 1 is fed into pretreatment step 2. Depending on the material, this can be a drying and/or pulverization device in which the material is prepared for the subsequent pyrolysis. The pretreated material 1 is brought into pyrolysis step 3. The pyrolysis step 3 leaves a pyrolysis gas 5 and a pyrolysis coke 5a.

The pyrolysis coke 5a is fired in firing 6. The heat from firing 6 is directed via a heat coupling 7 to pyrolysis step 3 and via a heat coupling 7a to a reaction zone 4 for pyrolysis gas. The waste gases 18 of firing 6 are cooled and diverted in a flue gas cleaning and cooling step 17. The waste heat obtained with the flue gas cleaning and cooling step 17 can be used, for example, for the drying in pretreatment step 2.

Depending on the method conditions, more heat may develop in firing 6 than is needed for heat coupling 7 and 7a. Steam can be generated with this heat. For this, feed water 9 can be fed via water treatment 10 and pump 11 into heat exchanger 12 which is mounted in firing 6. The steam 16 generated is fed into reaction zone 4. The pressure of the unneeded portion can be released via turbine 13 and further utilized as waste steam 16a.

The pyrolysis gas 5 is fed into reaction zone 4 with steam 16. In this reaction zone, the pyrolysis gas and the crack products of the condensable substances are reacted with steam to the desired gas product 15. The gas product 15 is then purified in a dedusting 8 and fine dedusting and quenching 14. It is also possible to feed a portion 19 of the gas product 15 into pyrolysis 3.

The addition of air and/or oxygen can be provided in the individual

method steps to influence the method steps of pyrolysis, firing, and reaction with steam.

Figure 2 shows the mass and energy balance of a pyrolysis step 101 and a reaction step 102 in the example of gasifying wood. Wood 104 and heat carrier medium 104a are introduced into pyrolysis step 101. Furthermore, heat flow 111a, that results from the size and consistency of the material flows consisting of wood 104 and heat carrier medium 104a, as well as the targeted pyrolysis temperature, is added. Pyrolysis step 101 leaves a mixture 105 consisting of wood charcoal and heat carrier medium, and pyrolysis gas 106.

Pyrolysis gas 106 enters reaction step 102. Furthermore, a heat loss 108 occurs. Additionally, the reaction heat of the wood charcoal formation 109 and steam 112 are fed into reaction step 102. In addition, another heat loss 110 occurs. Resulting from the heat and material streams fed in and diverted out, is still the heat quantity 111 to be fed in.

In Figure 3, the mass and energy balance of the wood charcoal firing 103 is represented. The material streams, mixture 105 (consisting of wood charcoal and heat carrier medium 104a), water 117, and air 113 enter into the firing, and also the material streams, waste gas 116, steam 112, and mixture 118 (consisting of heat carrier medium 104a and ash), exit. Heat streams that appear are heat stream 111 that is fed into reaction step 102, heat stream 111a that is fed into pyrolysis step 101, heat excess 114, and heat loss 115.

Figure 4 shows a device for carrying out the method according to the invention. A material 401 is metered via sluice 402 into shaft kiln 403. Simultaneously, heat carrier medium 414 is fed into shaft kiln 403 by conveyor 409 via sluice 410. Material 401 and the heat carrier medium 414 travel downwards in shaft kiln 403 and mix, whereby by means of the heat contained in heat carrier medium 414, material 401 is pyrolyzed at approximately 600°C.

At the lower end of shaft kiln 403, the mixture consisting of heat carrier medium 414 and pyrolysis coke 426 forming from material 401 through pyrolysis is fed onto grate 405 of brick-lined firing 407 through feeding 404. Firing 407 has starting booster 406. On grate 405, pyrolysis coke 426 burns, giving

off heat. In this way, heat carrier medium 414 is heated to approximately 1000°C. Heat carrier medium 414 consists of a coarse grained material such as sand, gravel, or split. During the firing, heat carrier medium 414 and pyrolysis coke 426 travel as far as worm 408 at the end of grate 405, by which the ash of pyrolysis coke 426 and heat carrier medium 414 are discharged. The majority of this mixture consisting of heat carrier medium 414 and ash is returned to shaft kiln 403 via conveyance 409 and sluice 410, where heat carrier medium 414 discharges the heat absorbed in firing 407 to material 401.

A small portion of the mixture consisting of ash of pyrolysis coke 426 and heat carrier medium 414 is discharged via cooling 411 and sieve 412. Through sieve 412, the ash of pyrolysis coke 426 is separated as fine material 413 from the coarser heat carrier medium 414 and heat carrier medium 414 is returned to the process. This separation is superfluous when the material to be gasified does not contain any ash-forming constituents.

The pyrolysis gas forming during the pyrolysis in shaft kiln 403 is withdrawn from the upper area of shaft kiln 403 via line 403a and fed into heat exchanger 417. Aside from water, carbon monoxide, carbon dioxide, hydrogen, and methane, the pyrolysis gas also contains higher hydrocarbons and tars as well as other organic, especially aromatic compounds as condensable components. Heat exchanger 417 is heated to a temperature of approximately 950°C by the waste gases of firing 407. At this temperature, the pyrolysis gas and the condensable substances react with steam that is contained in the pyrolysis gas. In addition, steam 416 is fed into line 403a for the reactions in heat exchanger 417. To further increase the temperature in heat exchanger 417, air 415 can also be added for a partial firing of the pyrolysis gas. To improve the cracking of the accompanying tars, a catalyst can be provided in the heat exchanger.

It is also possible to add the catalyst in the flow stream to the pyrolysis gas stream and to separate it again after heat exchanger 417 and reuse it.

Heat exchanger 417 leaves a gas product whose portions of carbon monoxide and hydrogen have been maximized. This gas is fed to heat ex-

changer 421 for utilization of waste heat and into washer 422 for gas purification.

Gas product 425 is withdrawn via induced draught ventilator 423.

The waste heat from heat exchanger 421 can be used to heat the pyrolysis gas to reaction temperature for the reaction with steam.

After it has flowed through heat exchanger 417, the waste gas of firing 407 is fed through heat exchanger 418 for waste heat utilization. After gas purification 419, waste gas 424 is discharged to the surroundings via induced draught ventilator 420.

Both firing 407 and also heat exchanger 417 are operated at a pressure that only slightly deviates from atmospheric pressure and generally is somewhat less than the latter. Induced draught ventilator 423 for gas product 425 and 420 for waste gas 424 are regulated and coordinated with one another so that the pyrolysis gas is fed through heat exchanger 417 and is not sucked through the shaft oven feed into firing 407.

Embodiment example

1000 kg/h wood are gasified in the device according to Figure 4. The wood contains 3% ash (free from water) and otherwise consists essentially of 50% carbon, 6% hydrogen, 42% oxygen, and 1.9% nitrogen, calculated without water or ash. The upper caloric value is 17.9 MJ/kg in the anhydrous state. The thermal gasification efficiency is 4.97 MW. The pyrolysis is carried out at 600°C and the reaction with steam at 950°C. The working pressure is atmospheric pressure.

Gravel with a grain size from 3 mm to 15 mm is used as heat carrier medium. The gravel is heated from 600°C to 950°C. Because of the required thermal performance of 380 kW, the cycling quantity of the heat carrier medium is five times that of the wood input, that is, 5000 kg per hour. The shaft kiln is 4.5 m high and has a diameter of 1.5 m, corresponding to a fluidized bed volume of 7.5 m³. The residence time in the shaft kiln is two hours.

In the pyrolysis, the wood is reacted so that 20 wt% of the wood remains

as wood charcoal. In the following table, the quantities and compositions of the wood and pyrolysis coke (wood charcoal) are listed:

Material flow	Wood	Wood charcoal
m [kg/h]	1000	200
H _u [MJ/kg] dry	17,9	33,5
C [wt%] daf	52,1	92,2
H [wt%] daf	4,8	2,6
O [wt%] daf	42,4	5,2
Ash [wt%] dry	3,4	17,0

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The following gas product is obtained:

Caloric value [MJ/Nm ³]	10,5
H ₂ [Vol.-% dry]	51,1
CO [Vol.-% dry]	39,7
CH ₄ [Vol.-% dry]	0,01
CO ₂ [Vol.-% dry]	9,2
H ₂ O [Vol.-%]	14,8
Chemical. enthalpy flow [MW]	3,9
Quantity [Nm ³ /h]	1.338

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The enthalpy flow of the wood charcoal in the firing is 1.86 MW. This is sufficient to generate a steam flow of 0.45 MW (360 kg/h at 950°C and atmospheric pressure) as well as to cover the heat requirement of the reaction of the pyrolysis gas with steam at the level of 0.84 MW. The firing efficiency is 85%.

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After accounting for the heat loss and loss through the waste gas flow, only

5

List of reference numbers:

	1	Material used
	2	Pretreatment step
5	3	Pyrolysis
	4	Reaction zone
	5	Pyrolysis gas
	5a	Pyrolysis coke
	6	Firing
10	7	Heat coupling
	7a	Heat coupling
	8	Dedusting
	9	Feed water
	10	Water treatment
15	11	Pump
	12	Heat exchanger
	13	Turbine
	14	Fine dedusting/quenching
	15	Gas product
20	16	Steam
	16a	Waste steam
	17	Heat exchanger/flue gas cleaning
	18	Waste gas
	19	Gas product
25	20	Air
	101	Pyrolysis step
	102	Reaction step
	103	Firing
	104	Wood
30	104a	Heat carrier medium
	105	Mixture

	106	Pyrolysis gas
	107	Gas product
	108	Lost heat
	109	Formation heat
5	110	Lost heat
	111	Heat feed reaction step
	111a	Heat feed pyrolysis step
	112	Superheated steam
	113	Air
10	114	Excess heat
	115	Heat loss
	116	Waste gas
	117	Water
	118	Mixture
15	401	Material used
	402	Sluice
	403	Shaft kiln
	403a	Line
	404	Feeding
20	405	Grate
	406	Booster
	407	Firing
	408	Worm
	409	Conveyor
25	410	Sluice
	411	Cooling
	412	Sieve
	413	Fine material
	414	Heat carrier medium
30	415	Air
	416	Steam

	417	Heat exchanger
	418	Heat exchanger
	419	Gas purification
	420	Induced draught ventilator
5	421	Heat exchanger
	422	Washer
	423	Induced draught ventilator
	424	Waste gas
	425	Gas product
10	426	Pyrolysis coke

Claims

1. Method for the gasifying of organic substances and substance mixtures in which
 - a) the organic substances are fed into a pyrolysis reactor in which the organic substances are kept in contact with a heat carrier medium whereby a rapid pyrolysis takes place in which the organic substances are reacted into pyrolysis products whereby the pyrolysis products consist of pyrolysis gases with condensable substances and a solid residue containing carbon,
 - b) the solid residue containing carbon and the heat carrier medium are fed to a firing in which the residue containing carbon is fired and the heat carrier medium heated and fed again to the pyrolysis reaction (heat carrier medium cycle)
 - c) the pyrolysis gases containing tar are reheated in a second reaction zone so that a gas product is obtained with at high caloric value,

characterized in that

 - d) the pyrolysis is carried out in a moving bed reactor or a rotary drum,
 - e) if necessary, a reactant such as steam is mixed in with the pyrolysis gases and then
 - f) are fed into an indirect heat exchanger in which the pyrolysis gases react with the reactant,
 - g) the firing waste gases are fed through the indirect heat exchanger such that their heat content is utilized for the reaction of the pyrolysis gases with the reactant, and
 - h) the ash of the solid residue containing carbon and the heat carrier medium is removed from the firing and recycled into the pyrolysis reactor at the input end for the organic material.
2. Method according to Claim 1, characterized in that the pyrolysis is carried out at a temperature of 550-650°C.

3. Method according to Claims 1 and 2, characterized in that the reaction of the pyrolysis gases with steam is carried out at a temperature of 900-1000°C.
4. Method according to one of Claims 1-3, characterized in that the reaction of the pyrolysis gases with steam is carried out in the presence of a catalyst.
5. Method according to Claim 4, characterized in that dolomite, calcite, nickel, nickel oxide, nickel aluminate, or nickel spinel is used as catalyst.
6. Method according to Claim 5, characterized in that the catalysts are used simultaneously as heat carrier medium for the heat carrier medium cycle.
7. Method according to one of Claims 1-6, characterized in that the hot pyrolysis gases are dedusted before the addition of steam.
8. Method according to one of Claims 1-7, characterized in that the catalyst is fed to the hot pyrolysis gases in an entrained flow mode and is separated out after the reaction with steam, and returned to the hot pyrolysis gases in the cycle.
9. Method according to one or more of Claims 1-8, characterized in that the pyrolysis gases are dedusted and quenched after the reaction with steam.
10. Method according to one of Claims 1-9, characterized in that a portion of the pyrolysis gas is fired and the heat is utilized for the pyrolysis and/or the reaction with steam.

11. Method according to one of Claims 1-10, characterized in that the solid residue containing carbon and the heat carrier medium are fed to a grate firing.
12. Apparatus for carrying out the method according to Claims 1-11 with a pyrolysis reactor, a firing for the pyrolysis residue, a reaction zone for the pyrolysis gases, a heat carrier cycle between the pyrolysis reaction and the firing, characterized in that a shaft kiln (403) or a rotary drum is equipped with a sluice (402) for a material used (401) and a sluice (410) for a heat carrier medium (414) in addition to a firing (407) with a grate (405), and the shaft kiln (403) has a feed (404) for the firing (407), and the waste gases (424) of the firing (407) can be fed to a heat exchanger (417) that is connected with the shaft kiln (403) via a line (403a) for the pyrolysis gases, and the firing (407) is connected via a discharge apparatus, such as a worm (408) to a conveyor (409) for the heat carrier medium (414).
13. Apparatus according to Claim 12, characterized in that the heat carrier medium consists of fire-resistant materials such as sand, gravel, split, aluminum silicate, corundum, graywacke, quartzite, or cordierite.
14. Apparatus according to Claim 12, characterized in that the heat carrier medium consists of molded bodies composed of metallic or nonmetallic substances such as steel or ceramic balls.
15. Apparatus according to Claims 13 and 14, characterized in that the heat carrier medium has a grain size of 1-40 mm.
16. Apparatus according to one or more of Claims 12-15, characterized in that the firing (407) is performed as a grate firing.

17. Apparatus according to one or more of Claims 12-16, characterized in that the heat exchanger (417) has a catalyst filling.
18. Apparatus according to one or more of Claims 10-17, characterized in that the pipes of the heat exchanger (417) consist of catalytically active material.
19. Apparatus according to one or more of Claims 12-18, characterized in that the heat exchanger (417) is assigned to a solid bed reactor with catalyst feed.
20. Apparatus according to one or more of Claims 12-19, characterized in that the heat exchanger (417) is first connected to a filter for dedusting.

[illegible][illegible]

3/PART

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533 Rec'd PCT/PTO 13 JUN 2000

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	Heinz-Jürgen Mühlen and Christoph Schmid
For	:	METHOD FOR GASIFYING ORGANIC SUBSTANCES AND SUBSTANCE MIXTURE
International Application No.	:	PCT/EP98/08217
International Filing Date	:	December 15, 1998
Priority Application No.	:	197 55 693.0
Priority Filing Date	:	December 16, 1997
Our Docket	:	PS-12772

"Express Mail" mailing label number EF321817985US

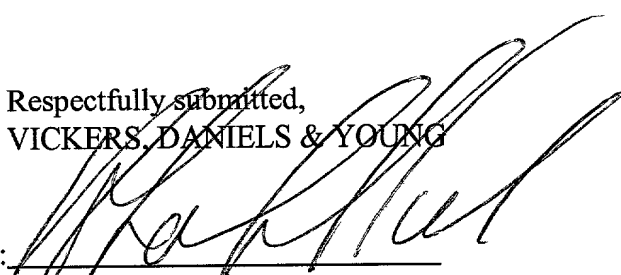
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Washington, D.C. 20231

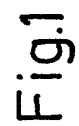
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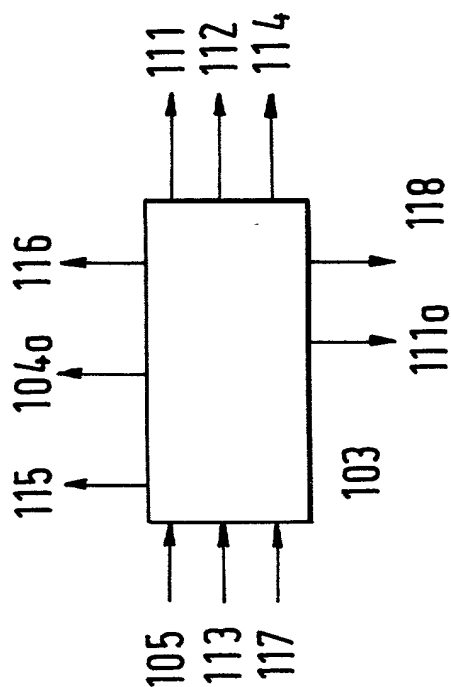
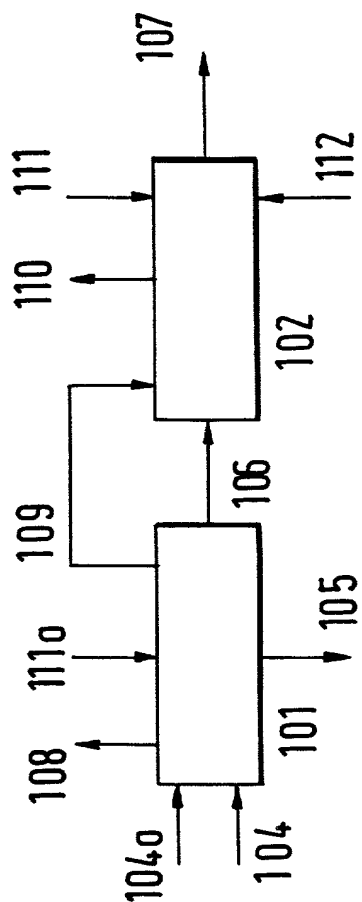
Please place the enclosed three (3) sheets of drawings in the record with regard to the above-identified patent application.

Respectfully submitted,
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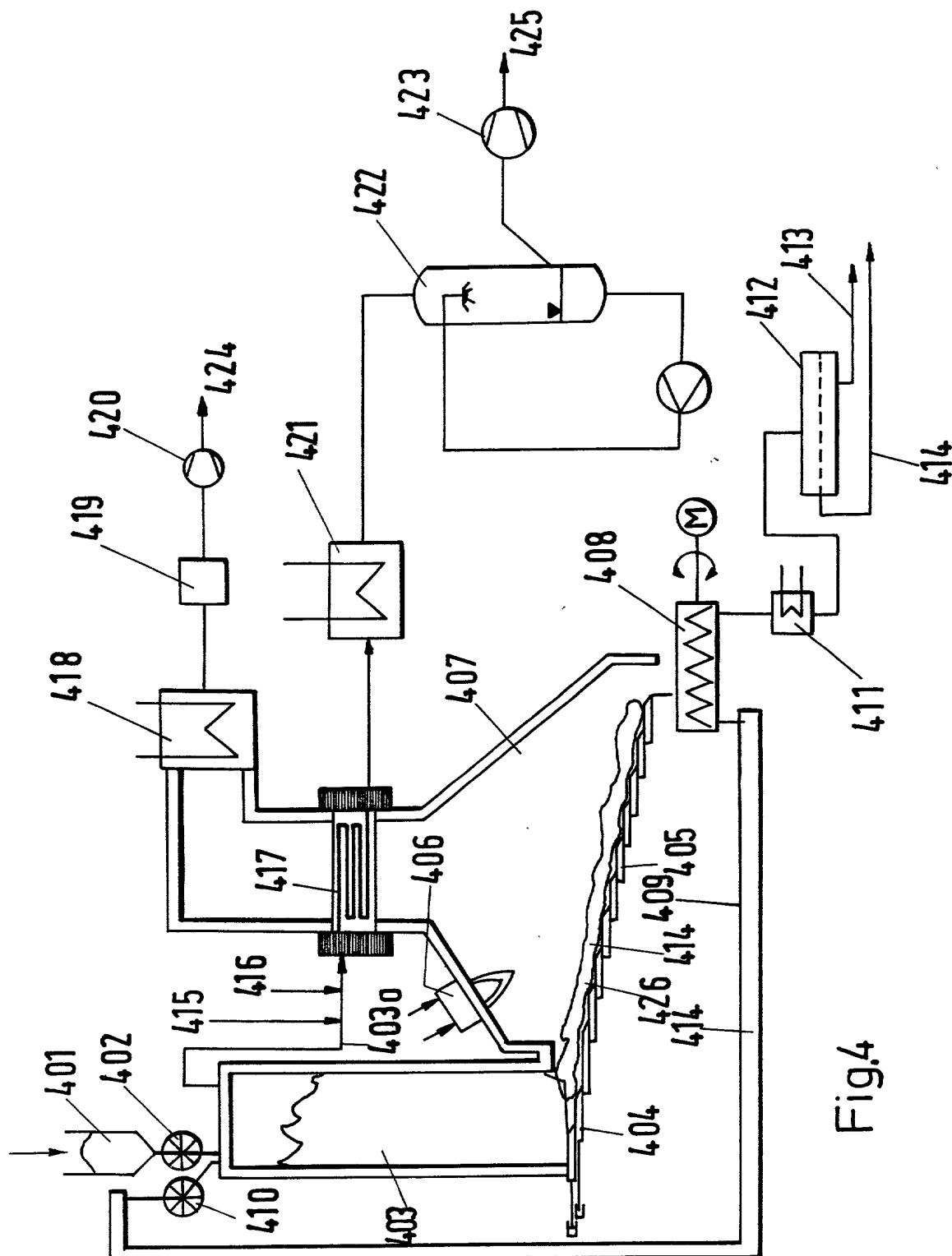


Fig. 4



Docket No. PS-12772

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DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATION/CONTINUATION-IN-PART PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated beneath my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

"METHOD FOR GASIFYING ORGANIC SUBSTANCES AND SUBSTANCE MIXTURE"

the specification of which

_____ is attached hereto.

X was filed on June 13, 2000 as Application Serial No. 09/581,384
and was amended on _____

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability and/or examination of this application in accordance with Title 37, Code of Federal Regulations §1.56(a).

I hereby claim priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent, inventor's certificate or provisional application listed below, and I have also identified below any foreign application for patent, inventor's certificate or provisional application having a filing date before that of the application on which priority is claimed:

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below, and, insofar as the subject matter of each of the claims of this application/continuation-in-part application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112. I acknowledge the duty to disclose information material to patentability as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

DE S.N. 197 55 693.0	December 16, 1997	Pending
Application Serial No.	Filing Date	Status

Application Serial No.	Filing Date	Status
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4
I hereby appoint the firm of Vickers, Daniels & Young, Robert V. Vickers (Reg. No. 19,504), E. Kent Daniels, Jr. (Reg. No. 19,598), Thomas E. Young (Reg. No. 28,924), and Brian E. Turung (Reg. No. 35,394), 50 Public Square, Suite 2000, Cleveland, Ohio 44113-2235, to act jointly or severally as my attorneys, each with full power of substitution and revocation, to prosecute said application and to transact all business in the Patent and Trademark Office and/or all the competent international authorities in connection with an international application connected therewith.

And I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

(Sign)

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2-66
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Dated this 10 day of July, 2000

Dated this 12 day of July, 2000